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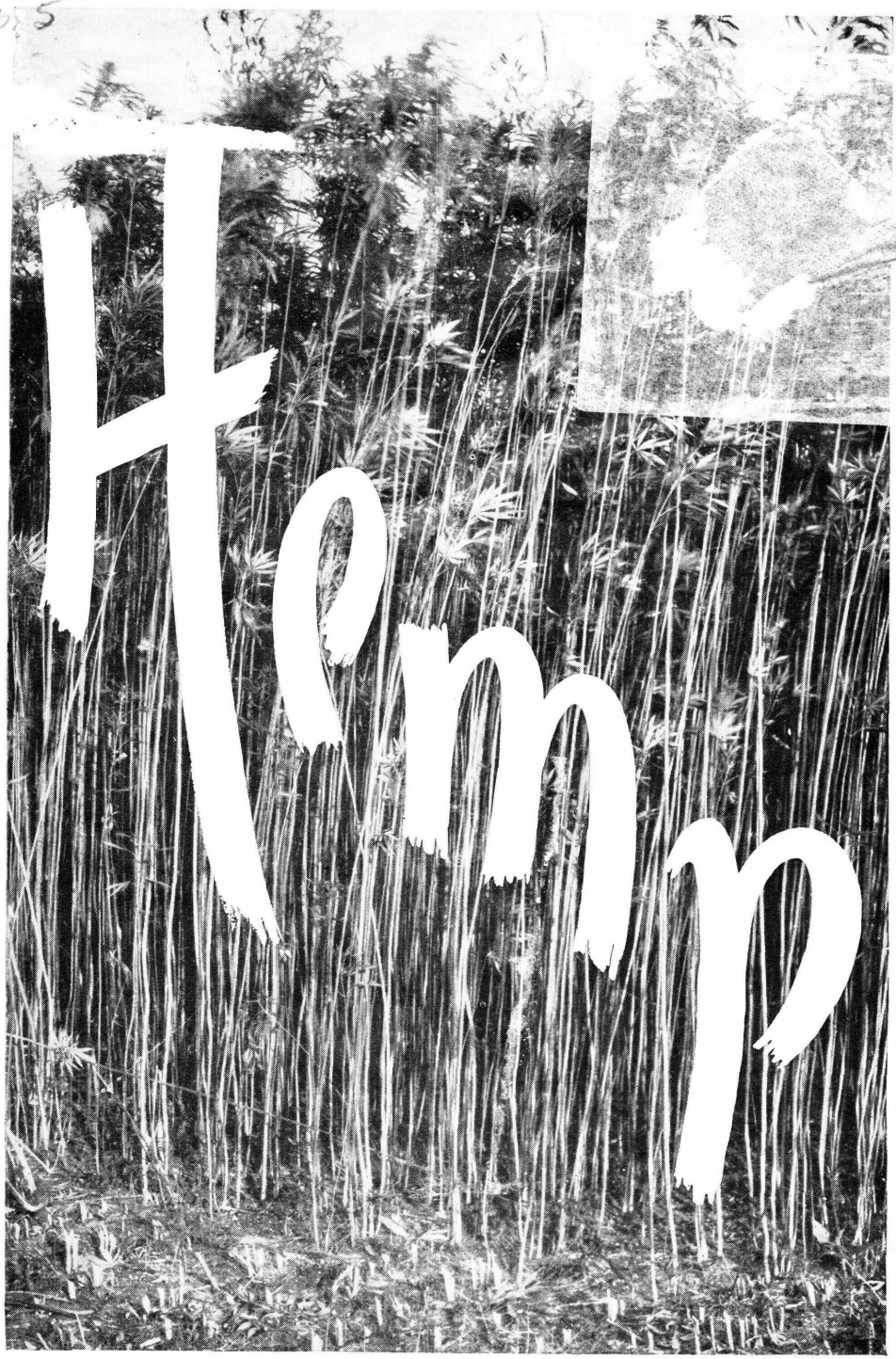
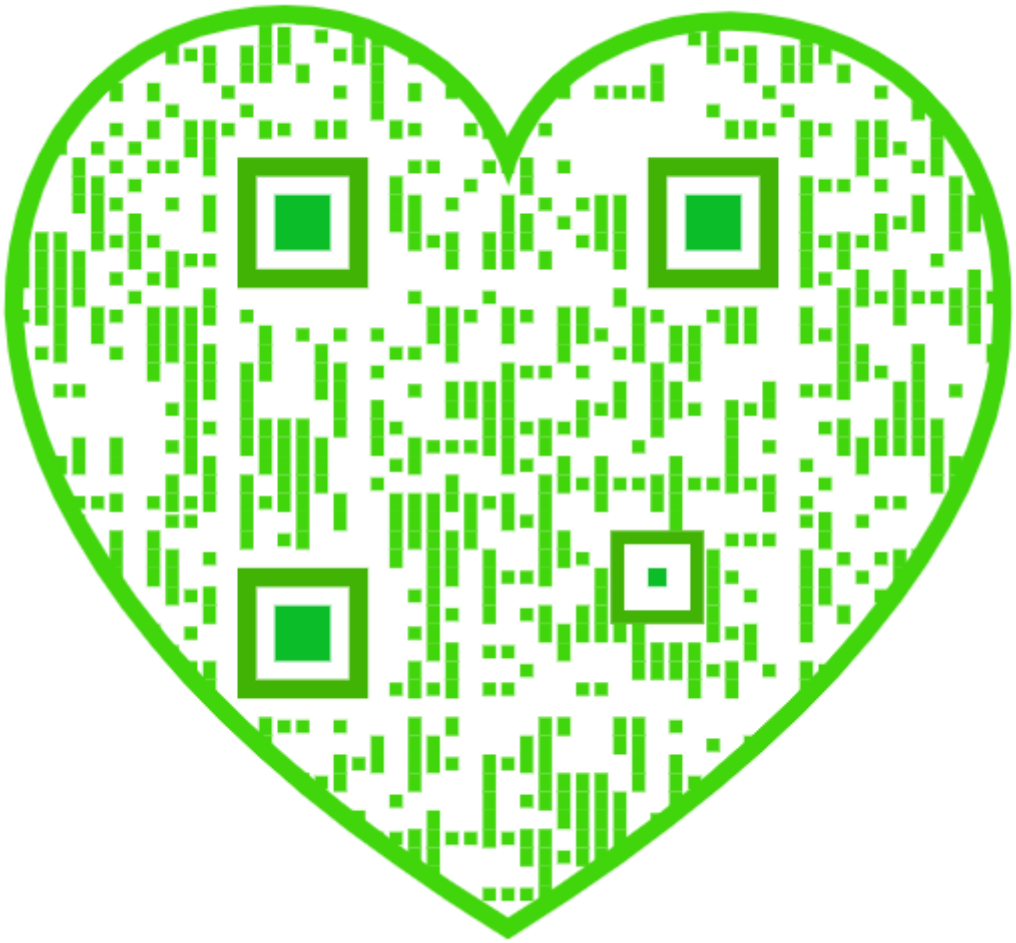


FARMERS' BULLETIN No. 1935
U. S. DEPARTMENT OF AGRICULTURE



Caution

THE HEMP PLANT contains the drug marihuana. Any farmer planning to grow hemp must comply with certain regulations of the Marihuana Tax Act of 1937. This involves registration with the farmer's nearest Internal Revenue Collector and the payment of a fee of $1. Although the fee is small, the registration is mandatory and should not be neglected, as the penalty provisions for not complying with the regulations are very severe. However, when a farmer signs a contract to grow hemp in the Government program of 1943, he also signs an application for a registration, and no further application is necessary. The registration must be renewed each year beginning July 1. This so-called "license" permits a farmer to obtain viable hemp seed from a registered firm dealing in hemp, to plant and grow the crop, and to deliver mature, retted hemp stalks to a hemp mill.

Washington, D. C. Issued January 1943

HEMP

By B. B. ROBINSON, *Senior Agronomist*

Division of Cotton and Other Fiber Crops and Diseases
Bureau of Plant Industry
Agricultural Research Administration

HEMP is now a strategic war crop. It is needed for making strong, durable twines and ropes, formerly made of fibers imported from the Philippines and the Netherlands East Indies.

Your Government is sponsoring the expansion of the hemp industry, and farmers will be assisted in the production, handling, and marketing of this crop.

By growing hemp in 1943, farmers in Minnesota, Iowa, Wisconsin, Illinois, Indiana, and Kentucky can serve their country and also have good prospects of profit for themselves.

Hemp should be planted on the most productive land on the farm—land that would make 50 to 70 bushels of corn per acre.

It is not a hard crop to grow. It is planted with a grain drill and harvested with special machinery rented from the hemp mills.

It is allowed to lie on the ground until the outer part of the stalks has rotted, freeing the fibers. This process is called dew retting.

The most important step in hemp farming is to stop the retting process at the proper time. (See pp. 12 and 13.)

This bulletin tells how to grow and harvest hemp. For more information write to the Bureau of Plant Industry, United States Department of Agriculture, or to your State experiment station, or consult your county agent or county Agricultural War Board.

What it is

Hemp is an annual plant that grows from seed each year, and therefore it can be brought readily into production. It produces twice as much fiber per acre as flax, the only other fiber that is its equal in strength and durability and that is known to be suitable for culture and preparation on machinery in this country.

When hemp seed is sown thickly for fiber production, the plants usually grow from 5 to 8 feet tall. However, when the plants are thinly spaced in rows for seed production, they may, under favorable conditions, reach a height of 12 to 16 feet. If the plants are not crowded, they become much branched and are bushy. Uniform stems approximately ⅜ inch in diameter and 5 to 8 feet long are especially desired for fiber production, because they can be handled well by the harvesting and processing machinery available in this country.

Hemp is a dioecious plant, that is, the staminate (male) and pis-

tillate (female) flowers are borne on separate plants, rather than both on one plant. The flowers of the two types of plants are different, but the male plant is easily distinguished from the female, as the anthers are about the size of a wheat kernel. The male plants die soon after discharging their pollen; this is usually about 3 to 5 weeks before the female plants mature seed and die.

The fiber of commerce ranges from 4 to 8 feet in length and has the appearance of a flat, fine ribbon. It lies very close to the epidermis or skin of the plant. Spinners desire the fiber ribbon 1/16 inch or less in width. The long strands of fiber are called "line" fiber to distinguish them from "tow" fiber, which consists of shorter, broken, tangled pieces.

It grows well in the Corn Belt

Hemp is recommended as a good crop for the Corn Belt States, because of their favorable climatic and soil conditions.

Most fiber-producing varieties of hemp require a frost-free growing season of 5 months or longer to produce seed and approximately 4 months for fiber production. Hemp will endure light frosts in the spring and survive frosts in the fall better than corn. It grows best when well supplied with moisture throughout its growing season and especially in its early stages of growth. Drought conditions, if accompanied by high temperatures, appear to hasten maturity before the plants are fully grown.

The vegetative growth of hemp should be uniform. This growth is noticeably affected if the soil is flooded or saturated with moisture for too long a period. The leaves turn yellow, and the plants die. Rainfall, well distributed during the growing season, is, therefore, desirable for uniform vegetative growth. Hemp should be planted only on well-drained soils and not on flat, heavy, impervious soils.

Climate is important not only in the growth of the plant but also in the preparation of the crop after harvest. It influences the method used in handling the crop and the labor requirements, which determine the cost of production. In the United States the common

practice (known as dew retting) is to cut the crop and let it lie on the ground. Exposure to the weather causes the fiber in the outer part of the stem to separate. Light snows and alternate freezing and thawing seem to improve or make the retting more uniform.

How to grow it

Soils and Fertilizers

Hemp should not be grown on poor soils. To obtain good yields and fiber of high quality, it is necessary to have a growth of uniform stalks 6 to 8 feet long. Short stalks, from poor nonfertile soils, seldom produce a high-quality fiber.

Fiber hemp grows successfully on soils of the Clarion, Tama, Carrington, Maury, Hagerstown, and Miami series, which, in general, are deep, medium-heavy loams, well-drained, and high in organic matter. Artificially drained areas of the Webster, Brookston, and Maumee series also give satisfactory yields. These soils are among the most productive soils of the Corn Belt. They produce average yields of 50 to 70 bushels or more of corn per acre. If land will not produce from 50 to 70 bushels of corn per acre, it should not be planted to hemp for fiber production.

Muck or peat soils are not recommended for the production of high-quality hemp fiber. The quantity of fiber produced per acre on these soils may be very high, but experience has demonstrated that the fiber lacks strength, which is the first requirement of hemp fiber for good cordage.

The inexperienced farmer usually gets advice from an experienced hemp-mill superintendent in the selection of the right soil. In fact, the farmer's contract to grow hemp usually specifies the exact field that it has been mutually agreed should be used for the hemp crop. This type of supervision by the company contracting for hemp has helped to prevent many crop failures. In the Government program, technical assistance will be provided by Federal and State agricultural agencies.

Hemp should not be grown continuously on the same soil, for the same reasons that many other crops are not adapted to such practices. In Wisconsin, fields previously used for a cultivated crop are selected for hemp planting in preference to ones upon which small grains have been grown. In Kentucky, bluegrass sod, if obtainable, is selected. Old pastures plowed up are well suited for hemp culture. Fields previously cropped to soybeans, alfalfa, and clover are excellent for hemp. A good rotation is to follow corn with hemp, and in Kentucky a fall cereal may follow the hemp.

Although hemp requires a rich soil, it does not remove from the farm an excess of plant-food material. Nearly all the leaves on the hemp plants, containing much of the plant nutrients removed from the soil, fall off during the growth and maturing of the plant. The remaining leaves may drop off in the field during the process of retting. Further, the plant stems lose about 20 percent in weight of soluble and decomposed materials, which leach out upon the fields, and the stubble may be plowed under. The plant in this manner returns to the land a large part of the plant nutrients that it removes during its growth.

Commercial fertilizers may be used to advantage on soils that are not well supplied with organic matter. Ordinarily, the best ferti-

lizer for hemp is barnyard manure, but commercial fertilizer can be used to advantage to supplement manure. Lime applications may be supplied on acid soils to advantage. Consult your county agent for recommendations as to amounts of fertilizer and lime to apply.

Seed

The period of flowering of the hemp plant may extend over several weeks, and as a result the seed does not all mature at one time. Hemp seed for sowing frequently contains some immature green to yellowish-green seeds that may not germinate well. Good hemp seed for sowing should be relatively free of such seeds and should germinate 90 percent or better. As the oil content of hemp seed usually ranges between 29 and 34 percent, the seed should be kept cool and dry, as it spoils rapidly under warm and damp conditions. Hemp seed seldom retains its germinating power well enough to be used for seed after 2-years' storage.

When to Plant

Hemp should be planted in the spring just before corn. In a program calling for small spring grains and corn, the farmer should plan to plant his hemp between the time he plants his small grains and the corn.

Seeding

Hemp grown for seed production should be sown in rows or hills. The hills are commonly spaced 5 by 5 feet, with 6 to 10 seeds to the hill, planted not more than ½ inch deep. The plants are thinned to 3 to 5 to a hill. If care is taken to save seed, about 1½ pounds will sow an acre. Most farmers use more seed, and frequently the crop is replanted because of late floods or failure to obtain good stands.

Hemp grown for fiber should be sown with a broadcast seeder or with a grain drill. A drill with 4 inches between drill tubes is preferred to one with 6 inches or more. The seed should not be planted deeper than 1 inch, and a depth of ½ inch is preferred. If the seed is planted deep, the hemp seedling is not capable of pushing its way to the surface of the ground. A slight crust on the ground frequently results in a poor stand. If the seedbed is loose, disks on a seed drill may cut too deep into the soil and the seed will be sown more than 1 inch deep. In such cases, to make certain that the disks do not cut too deep into the seedbed, they should be tied to the seed box.

A standard bushel of hempseed weighs 44 pounds. The rate of seeding hemp for fiber production ranges between 3 and 5 pecks of seed per acre. In Kentucky, where hemp is hand-broken, it has been the practice to sow 3 pecks (33 pounds) per acre. However, when the hemp is to go to the mill, 1 bushel per acre gives a product that is better suited to milling. Wisconsin and other Corn Belt farmers have commonly sown 5 pecks per acre. The lighter rate of seeding in Kentucky produces larger stalks. These stalks are easily broken, and the fiber is easily prepared by the hand-breaking methods that have been used there since colonial days. Machine methods of breaking and scutching to prepare the fiber are used in Wisconsin, and

recently to some extent in Kentucky. The machines will handle finer stems, and the sowing of 5 pecks is advisable where hemp is to be prepared by machine.

A good practice in planting hemp for fiber production is to sow around the edge of the field next to the fence a 16- to 18-foot width of small grains, which may be harvested before the hemp. Space is thus provided for the harvester to enter the field and begin cutting without injuring the hemp. It also prevents hemp plants at the edge from growing too rank. Uniform plants are necessary for uniform fiber quality.

Culture

Fall plowing in Wisconsin gives better results with hemp than spring plowing.

Hemp for fiber production requires little or no cultivation or care after planting until the harvest; but if, after seeding and before the seedlings emerge, the ground crusts badly it may be advisable to roll the field to break the crust. Hemp for seed production should be cultivated the same as corn; that is, sufficiently to keep back the weeds. Spudding out Canada thistles where they appear in dense stands in hemp fields should be done when the hemp is only a few inches high. In most cases hemp will compete well with weeds, if the hemp gets off to a good start.

Varieties to grow

The fiber hemp grown in the United States by the early colonists was of European origin; but our present hemp, commonly known as Kentucky or domestic hemp, is of Chinese origin. Few importations of hempseed have been made in recent years for commercial plantings, as imported seed has not proved as productive under domestic conditions as Kentucky hemp.

Enemies

In the United States there are no hemp diseases of economic importance, and hemp has not been seriously attacked by insects. The European corn borer and similar stem-boring insects occasionally kill a hemp stem. However, they have not proved important, perhaps because hemp has not been grown to any extent in the sections of the United States where the European corn borer is a serious pest. Seedling plants are frequently attacked by cutworms and white grubs after spring plowing of sod land.

Broom rape is a small weed 6 to 15 inches high that is parasitic on the roots of hemp, tobacco, and tomatoes. It usually grows in clumps and has purple flowers, which produce many very small seeds. These adhere to the waxy flower parts surrounding the hempseed and are distributed in this manner. Broom rape can be very serious on hemp if proper control measures are not followed. Only well-cleaned hempseed and seed from fields containing no broom rape should be sown.

Hemp has been recommended as a weed-control crop. Its dense, tall growth helps to kill out many common weeds. The noxious bindweed, a member of the morning-glory family, is checked to some extent by hemp. Unfortunately, bindweed and several other species of morning-glory have seeds so near the same size and weight of hemp seed that mixtures obtained in producing hempseed are carried to the field planted for fiber production. In growing hemp for seed all vine weeds of this type found on the hemp stalks should be removed before the hemp plants begin to produce seed.

Harvesting

Time to Harvest

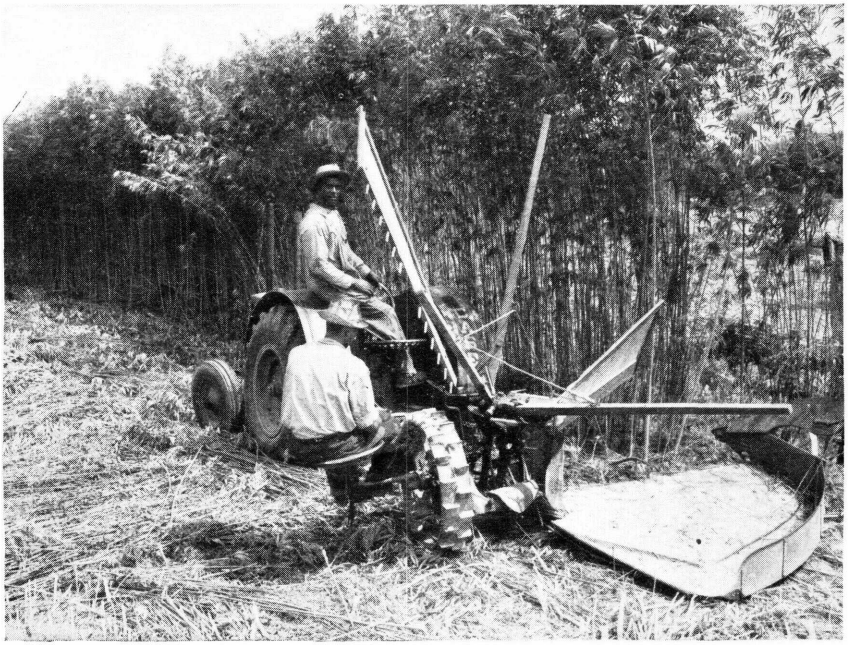
Hemp is harvested for seed production when the plant on being shaken sheds most of its seed. This occurs when the seeds are fully mature on the middle branches. The seeds will mature on the lower branches first and on the top of the plant last. The common method

of harvesting hemp for seed production is to cut it by hand and shock it to permit more seed to mature and cure before threshing. The harvesting should be in the early morning or on damp days when the seeds do not shatter so much as they do in the warmer and drier part of the day. Threshing of the seed hemp should be done on dry afternoons. In threshing, the seed shocks should be placed on large canvas cloths 24 by 24 feet and then be beaten with long sticks to remove the seed.

Hemp is harvested for fiber production when the male plants are in full flower and are shedding pollen. By harvesting before the male plants die, the retting of both male and female plants is more uniform, as both types of plants are still green and growing. The harvesting period may extend for 2 weeks or longer. Very early harvested hemp may produce a finer and softer fiber than that harvested later, but it is usually weaker. The fiber from hemp that has been harvested so late that many seeds have matured does not possess so good cordage and textile characteristics as fiber from hemp harvested earlier. Hemp stalks should be relatively free of leaves except a few at the very top before harvesting. This is important when hemp is shocked after harvest, as it makes the top of the shock smaller so that less rain can enter the shock.

Machinery

Harvesting methods vary with locality and climate. In Kentucky, hemp may grow to a height of 15 feet or more. These long stalks are difficult to handle with machinery. Self-rake reapers (see below) have been used in harvesting hemp for many years, and they probably do better work with very tall hemp than any other machine now available. A modified rice binder, which cuts and



binds the hemp into bundles, is also available, although difficulty in handling the very tall hemp may be experienced. This latter type of machine can be used for short hemp in areas, such as Kentucky, where hemp must be shocked within a few days after harvest to avoid sunburn.

In the northern part of the Corn Belt the hemp usually does not grow so tall and therefore can be handled more easily with machines. During the first World War hemp-harvesting machinery was developed. These harvesters (see above) in one operation cut an 8- or 9-foot swath and elevate the stalks to a quarter-circle platform where they are turned automatically and dropped or spread on the ground for retting. The butts of the stems all lie in the same direction and are relatively even. The thickness of the layer of stalks in the swath influences the speed and uniformity of the dew retting. Machines of this type, because of their labor economy, are recommended for use in the Northern States, where hemp can be safely spread for retting when harvested.

Hemp harvesters are usually owned by the hemp mills. They are rented to the individual farmers, who usually furnish the motive power and the labor to run the harvesters.

Retting

Retting is the partial rotting of the hemp stalk. It permits the fiber in the stalk to separate easily in long strands from the woody core. The fiber strands break if unretted stems are bent or broken.

In this country the usual practice is to ret hemp by allowing it to lie on the ground, where it is exposed to rain and dew. This method is called dew retting.

Dew retting is dependent upon dews and rains to furnish the moist conditions necessary for the growth of the molds that cause the retting. In warm, moist weather the retting may require 1 to 2 weeks, but usually 4 to 5 weeks is required for retting in Kentucky and Wisconsin. Hemp has remained spread under snow in Wisconsin until spring without serious injury, but more often hemp left under snow all winter is overretted and ruined.

Underretting and Overretting

If hemp stalks are lifted from the ground before they are sufficiently retted, the fiber will not separate easily from the woody hurds (small pieces of the woody core of the plant) in milling. However, if the retting is permitted to go too far, the fiber separates very readily from the core, but the adhesive substance between the individual fiber cells in the long strand breaks down and the fiber is weak. Hemp further overretted produces mostly short broken strands of fiber called tow fiber, which is less valuable than the long parallel strands of fiber called line fiber.

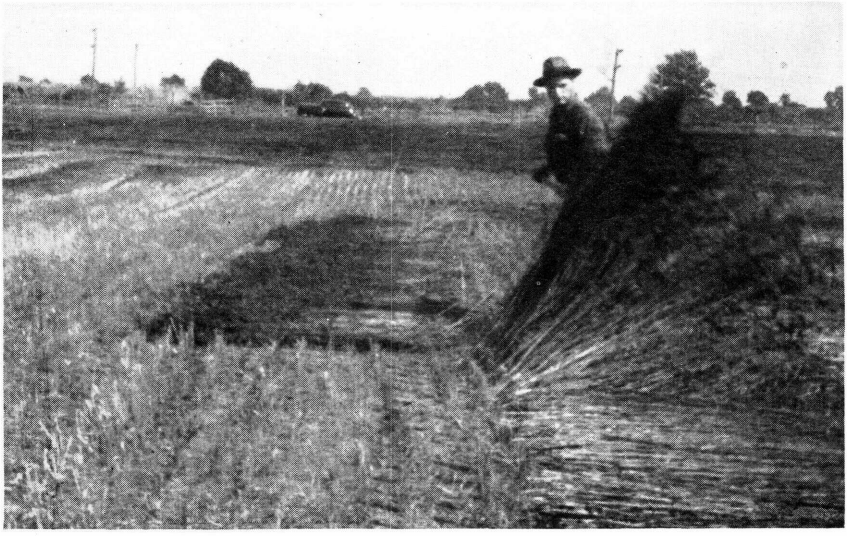
Nowhere in the growing or processing of hemp is good judgment more needed than in determining the time to end the ret. Experience and good judgment are necessary to determine just when the hemp stalks should be lifted from the field and bundled. The lifting and shocking stops the retting action. The value of the fiber can be cut in half or entirely lost by several days' overretting in warm weather.

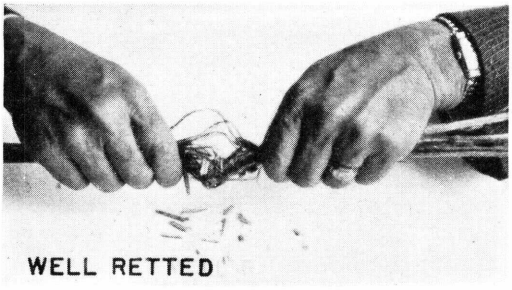
Sunburning

In Kentucky, hemp spread immediately to ret after harvest is apt to sunburn, or sunscald. It is common belief that the hot, bright days in August and September in some way cause deterioration of the fiber if spread for retting. Sunburned fiber is uneven in color, usually has less strength, and possibly is drier and more harsh than fiber not sunburned. In order to avoid sunscalding, the hemp is shocked after being harvested and not spread for retting until the cooler days of November. In locations having climatic conditions similar to those prevailing in Wisconsin, sunscald of hemp is rare.

Turning Stalks

In dew retting the spread stalks should be turned once or more during the retting period. This aids in bleaching the stalks and results in fiber of more uniform color and quality. The turning is





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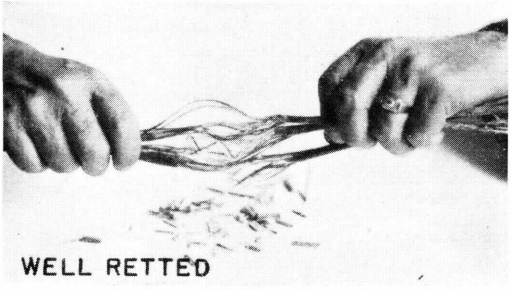

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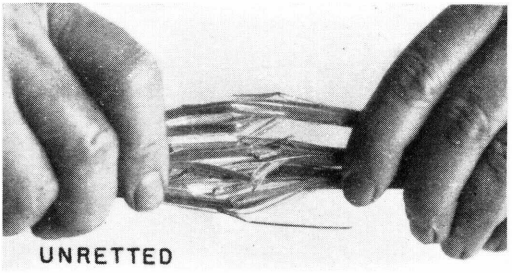

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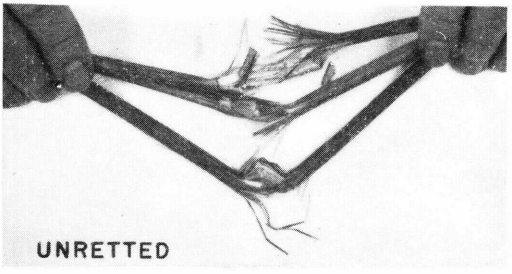


UNRETTED

done by workmen using bent poles approximately 8 to 10 feet in length. The poles are pushed under the head ends of stalks in the swath, and the stalks are turned over without moving the butt ends.

In turning the straw the workmen start in the middle of the field, turning the first swath into vacant center space. The second swath will be turned to lie where the first swath had been, and so on.

Care should be exercised in turning to prevent the stalks from tangling. The more hemp is handled, the more tangled the stalks may become. Tangled hemp is more difficult to process and produces a high proportion of tangled, short, tow fiber.

Testing the End Point of the Ret

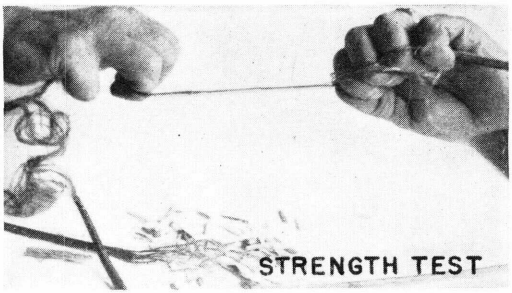
A few days too long in the field may make the difference between retting and rotting. Therefore, it is most important that inexperienced farmers obtain the assistance of the hemp-mill superintendent or an experienced grower in determining when to stop the retting.

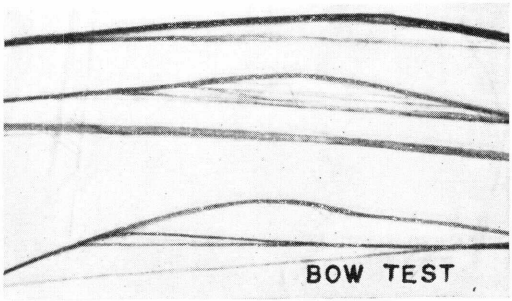
Dry hemp stalks should be tested when possible to determine the degree of retting. Three to six stalks are taken in both hands and bent back and forth to perform the break test. If properly retted, the fiber should not break when the woody core breaks. The hurds should fall free of the fiber in the breaking and shaking between one's hands. If the hemp is only partly retted, some hurds will adhere to the loosened fiber. Unretted hemp fiber is usually green or light yellow. Dew-retted hemp is usually slate gray or black.

After the fiber is broken free, its strength should be tested by break-

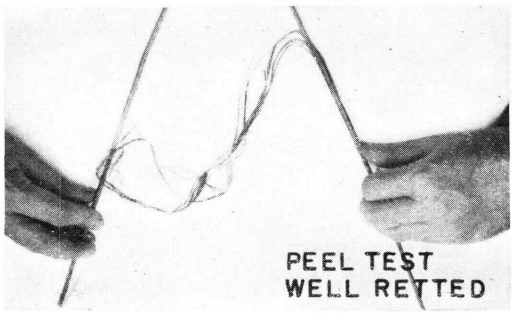
ing a small strand between the fingers. A small strand of fiber not twisted and about $\frac{3}{32}$ inch wide should break with great difficulty and with a decided snap. If it is very weak and breaks with little or no snap the hemp is probably badly overretted or may have been grown under unfavorable cultural conditions. (See p. 5.)

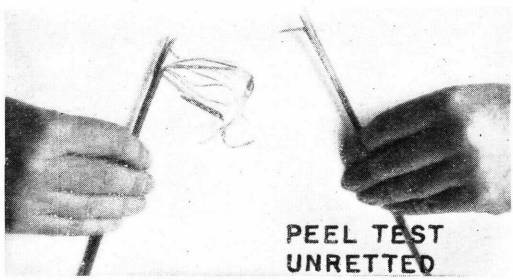
An indication that the retting end point is near is that the hemp makes "bowstrings." In a small percentage of the stems, less than 1 to 5 percent under certain conditions, the middle of the stalks appears to ret first. The fiber comes free from the middle and forms a string fastened at the top and bottom of the stem, not unlike a bowstring. If bowstring stems are found, a sample of the hemp should be taken to the hemp-mill superintendent as soon as possible for verification of the retting end point. The bowstring condition is only a supplementary aid in determining when to stop the retting, and it may or may not occur in properly dew-retted hemp.





Some experienced hemp producers use the peeling test for determining the degree of retting. This is accomplished by peeling the fiber away from the butt ends of the stems. If properly retted, the fiber should peel freely from the woody core of the stem. If the hemp is not sufficiently retted, the fiber will break after a few inches have been peeled. This free-peeling stage is desirable for breaking hemp on hand breaks. Where hemp is to be processed by machinery the retting need not progress quite so far as is necessary for hand breaking.



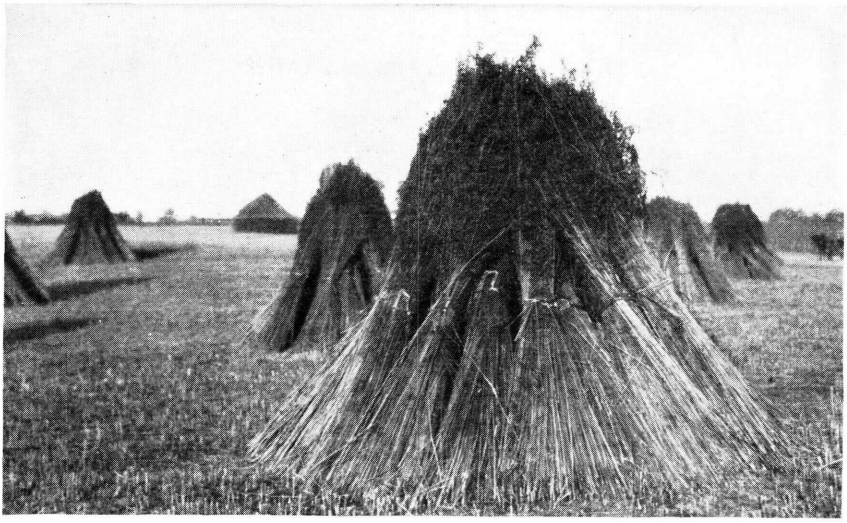


Picking Up the Retted Stalks

Hemp stalks may be picked up by hand. This method has been used from early times and is satisfactory where labor is plentiful. However, in this country it is being replaced by machine pick-up binders.

In picking up the straw by hand, small sticks about 3 feet long with a single steel or wooden hook on the end are used. The hemp is raked into bunches with these implements, and usually tied. Hemp-fiber bands are used in tying the bundles. An inexpensive "buck" (see above) may be used to bunch the hemp, or it may be bunched with a pitchfork.

The most efficient method is to use the pick-up binder. These machines, drawn by tractors, cover about an acre an hour. They



pick up the retted hemp stalks and tie them into bundles in one operation. The machines are part of the modern hemp-mill equipment and are rented to farmers.

Dew-retted hemp is usually shocked after being picked up. The hemp remains in the shock until it is transported to the mill.

Extra Care Insures Extra Profits

The farmer's job is done when he delivers the hemp to the mill. All further processing to prepare the fiber is part of the milling operation. However, it is of interest to both farmers and mill operators to attempt to keep the hemp stalks and fiber well butted. This means keeping the butt ends of the stalks or fiber in a bundle all even. Every time the hemp stalks are handled, care should be taken to see that this is done. If the hemp stalks are well butted in the bundle when processed, the milling operations can be carried out more economically. Tangled, uneven bundles are more difficult and require more time to handle. The yield of high-value long-life fiber is much greater if the stalks are well butted.

Hemp stalks are considered most desirable if they are less than half an inch in diameter. The thickness of a pencil is frequently used to illustrate the size of desirable stalks. The larger diameter stalks have a lower percentage of fiber than finer stems, are harder to break, and produce more tow fiber.

Hemp stalks grown on unproductive soil usually contain a lower percentage of fiber, and this fiber may be coarse, harsh, and of low strength, so that it breaks into tow in milling.

Stalks underretted frequently must be run through the mill breaker a second or third time to remove the remaining hurds. This increases the milling labor costs, and the resultant fiber may be reduced to a low grade. On the other hand, overretted hemp must be milled as little as possible, with less pressure exerted on the rollers and a slower speed of the scutcher wheel to keep from making an excess amount of tow fiber.

Yields

Hemp yields have been extremely variable when this crop has been planted in new areas by inexperienced farmers. In Wisconsin and Kentucky, where only experienced farmers have grown the crop in recent years, the yields have not varied a great deal. The crop has been reasonably dependable and has not often been injured by storms or droughts.

The average yields per acre for experienced farmers are approximately 2¼ to 2½ tons of air-dry retted hemp stalks; 850 pounds total fiber. Under the Wisconsin machine-milling system the yields may average 450 pounds line fiber and 400 pounds tow fiber; under the Kentucky hand-breaking system they may average 775 pounds Kentucky rough and 75 pounds tow.

If hemp is planted for seed production, the average yields per acre are approximately 15 bushels or 660 pounds, on bottom land, and 12 bushels on uplands.

The yields given above apply to hemp culture previous to 1941, when the area of production was very localized and the number of growers small. It is reasonable to assume that any large expansion would distribute the hemp in less productive areas and that the average yields would be smaller.

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